Structured Knowledge Representation: An Improved Methodology for Communication of Hospital Policy

Jeffrey J. Guterman, M.D., M.S., Nicholas J. Mankovich, Ph.D.,
Stacy Weinstein, J.D., Bruce Picken M.D.

Departments of Medicine, Emergency Medicine, Radiological Sciences, and Psychiatry
Medical Informatics, Olive View-UCLA Medical Center,
UCLA School of Medicine

The optimal operational integrity of a health care facility depends upon the correct interpretation of and adherence to well designed and written policies. Memos describing policy and procedures can be ambiguous, hindering their comprehension rather than helping it. Two alternative methods have been developed for communicating policy: the algorithmic flow chart and a computer decision support program. To determine the best means of communicating policy, the written memo, flow chart, and computer program were compared in scenario presentation interviews. The average time required to complete the test scenarios was five minutes for the traditional memo, two minutes for the algorithm, and two minutes for the computer program. Accuracy improves markedly from the traditional memo to the computer program. ANOVA reveals that the flow chart and computer program are significantly superior to memos as methods for communicating hospital policy.

INTRODUCTION

Hospital policies and procedures allow employees access to guidelines that facilitate the efficient and effective operation of large health care institutions. Traditionally, manuals containing policies written in narrative form serve as the official format for documentation of policy and procedures. An employee, even after finding the policy manual and the correct policy within the manual, may find memos ambiguous and difficult to understand. As is the case with patient education material, one possible explanation may be the discrepency between the level of the written document and the comprehension ability of hospital staff.[1,2]

The information age has brought with it two new technologies, the algorithmic flow chart and on-line computer decision support — both have the potential to improve communication over the traditional written memo (Figure 1). The algorithmic flow chart (Figure 2) is a paper-based system designed to codify the decision-making process presented in the written policy memo. The computerized decision-assist program (Figure 3) takes the process one step further by presenting to the user, via computer, only that portion of the decision algorithm that pertains to a given scenario. Formalization of the decision making process has proven to be a valuable technique in a variety of clinical settings when utilized by health care professionals.[3,4,5] We determined, in a structured, interactive presentation experiment, the speed and accuracy of the three methods of communicating hospital policy.

MATERIALS AND METHODS

Two standard hospital policies, one concerning a clinical issue (an employee accidentally being stuck by a needle) and the other a procedural issue (the cancellation of a radiological procedure by a non-physician) were chosen as test policies. These hospital policies were manually converted into a written format understandable by *All-Clear*[6], an inexpensive, commercially available, flow chart generating program (Figure 4). *All-Clear* creates decision-making flow charts. Subsequent processing of *All-Clear* instructions converts the diagrams into a decision-assist database (Figure 3) used by the custom written decision-assist program.

Test subjects included a convenience sample of doctors, nurses, technologists, and clerical personnel. All were

If Employee Health is open, send the employee immediately to Employee Health. If the injury occurs when Employee Health is closed, do the following in the Department of Emergency Medicine, then send employee to Employee Health the next working day.

A. Any employee who receives a needlestick and the status of his/her hepatitis antibody is unknown, or, if they are known to be negative, do the following:

1. Obtain HIV consent - put in employee's record. Draw blood for Hepatitis panel (HbsAg, HbcAb, HbsAb), RPR, and HIV.
2. Obtain Hepatitis vaccine consent. Give Hepatitis B Immune Globin (HBIG) 0.06 ml/kg IM (gluteal muscles).

⋮

Figure 1. Excerpt from a typical hospital protocol for dealing with employee needlesticks.

trained by the same researcher on the use of the written memo, algorithm, and the decision support program. The scenario and policy used for training was not repeated during the experiment. Each subject was tested in two of the three formats. To avoid a learning bias, a different scenario and policy was used for each arm of the study. The different formats were presented in random order.

A total of 59 subjects participated, each of whom completed two scenarios and formats. Forty scenarios were completed using the written memo, 40 using the algorithmic flow chart, and 38 utilizing the computer decision support program. The subjects were physicians (27%), nurses (12%), ancillary staff (15%), clerical staff (25%), or other positions (21%). The overall breakdown was 68% line staff, 27% supervisors, and 5% managers.

Following training, each subject was read a description of a test scenario (either employee needlestick or radiology cancellation). By using the selected policy representation (memo, algorithm or computer decision-assist program) subjects were allowed to ask questions of the experimenter. In an appropriate interpretation of policy, the subject would verbally describe the proper way to handle the scenario.

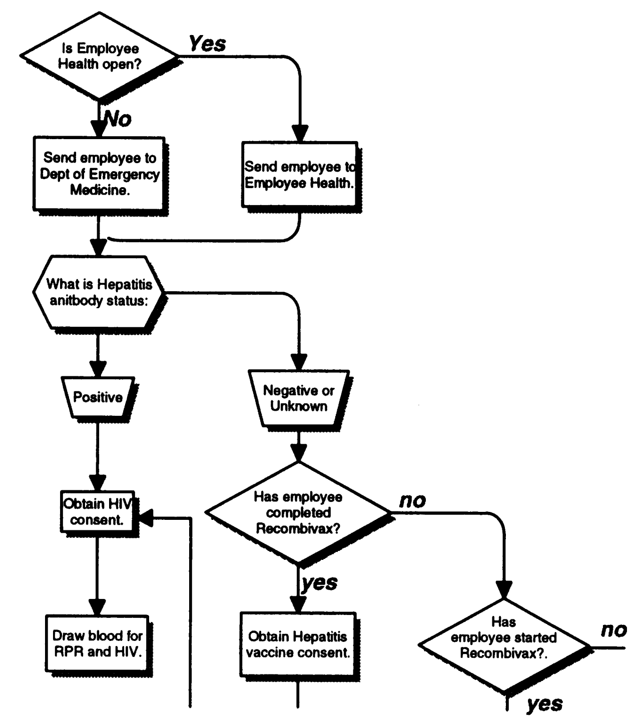

Figure 2. Excerpt from a flow chart protocol detailing how to handle an employee needlestick.

```
What is Hepatitis antibody status
1. Positive
2. Negative or Unknown
3.
4.

Enter the number of the best answer
                                  _______

| F1 |     F2     |    F3    | F4 |  F5  |
|Help|How to ask|Why ask|Note|Video|
```

Figure 3. A sample screen from the data-base program protocol dialog for handling an employee needlestick.

During the question/answer dialogue leading to a resolution of the scenario, one experimenter (SW) timed and recorded the accuracy of responses according to the subject-suggested action. Errors were divided into two categories: errors of commission and errors of omission. Errors of commission are defined as performing an action not expected by the scenario. Errors of omission are defined as not performing a correct action expected by the scenario.

Subjects were tested in their usual work environment. After completion of the timed and scored portion of the

```
-prnds01
Is Employee Health open?
        (Yes) Send employee to Employee
        Health.
                >prnds02
        (No) Send employee to Dept of
        Emergency Medicine.
                >prnds02
?end

-prnds02
What is Hepatitis antibody status:
        (Positive)
                >prnds05
        (Negative or Unknown)
                >prnds04
:end

-prnds04
Has employee completed Recombivax?
        (yes) Obtain Hepatitis vaccine
        consent.
                Give 1 ml Recombivax.  Note
                lot number.
                >prnds05
        (no) >prnds06
?end

-prnds05
Obtain HIV consent.
Draw blood for RPR and HIV.
Consider tetanus toxoid or dT. Note lot
number.
                >prnds12
.
.
.
```

Figure 4. Excerpt from the *All-Clear* language coding for the handling of the needlestick.

study, subjects answered a series of follow-up questions designed to ascertain opinions regarding the different methods of policy communication.

RESULTS

The mean time for completion of the scenario was 4 minutes and 59 seconds (standard deviation = 2 minutes, 12 seconds) for the written memo, 2 minutes and 15 seconds (s.d. = 58 seconds) for the algorithmic flow chart and 1 minute and 49 seconds (s.d. = 27 seconds) for the decision support program. Table 1 and Figures 5 and 6 show the average errors of omission and errors of commission for all scenarios.

Table 1. Summary of protocol errors for the policy comprehension study. See the text for details of Scheffé multiple comparison tests.

Policy	Format	Errors of Commission		Errors of Omission	
		Mean	S.D.	Mean	S.D.
Needle-stick	Memo	1.8	0.9	1.8	1.5
	Algorithm	0.4	0.8	1.0	1.3
	Computer	0.0	0.0	0.9	1.8
	ANOVA:	p = .001		p = .02	
Radiology	Memo	2.3	1.1	3.0	2.4
	Algorithm	0.7	1.2	1.7	2.5
	Computer	0.2	0.5	0.8	2.1
	ANOVA:	p = .001		p = .002	

A one-way analysis of variance (ANOVA) on format with Scheffé's multiple comparison procedure was used to test the significance among the three presentation formats. The percentage of errors of commission and omission were calculated. These format percentages were then arcsine transformed for variance stabilization. The one-way analysis of variance procedure tested for differences in error percentage among the formats for each policy. Scheffé's multiple comparison procedure was then applied to identify significant differences between formats. The equality of variances assumption was tested using Levene's test.

For the radiology policy, the ANOVA indicated significant differences among formats with a p-value equal to 0.002 for errors of omission and 0.001 for errors of commission. Scheffé's multiple comparison procedure showed that memo and computer formats were significantly different at the 0.05 level for errors of omission. For errors of commission, memo differed from algorithm and computer at the 0.01 level. For the needlestick policy, the calculated p-value for the ANOVA was 0.02 for the errors of omission and 0.001 for the errors of commission. Scheffé's multiple comparison procedure demonstrated again that memo and computer formats were significantly different at the 0.01 level for errors of omission. Errors of commission differed for memo from algorithm and computer at the 0.01 level.

DISCUSSION

With a 55-64% average improvement in speed and 58-79% average improvement in accuracy, the computer-based format for communication provides a mechanism for the improvement of hospital operations through increased employee understanding of policy. This study assumes that hospital policy reflects good operational practice. This is not always the case. As we codify policies for our institution, we find that not all contain clear direction and logic. Perhaps one of the greatest advantages in the process of creating the decision-assist database is that the authors of policy must remove all ambiguities. The computer program cannot compile directions that contain logical errors, and thus acts as a strict logical editor for our policies.

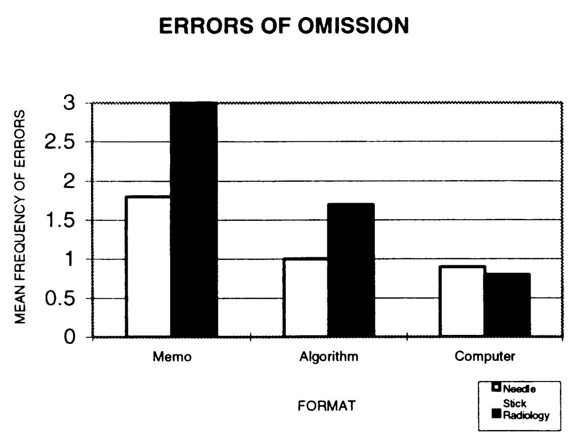

Figure 5. Mean frequency of errors of omission by format of presentation and the scenario policy used.

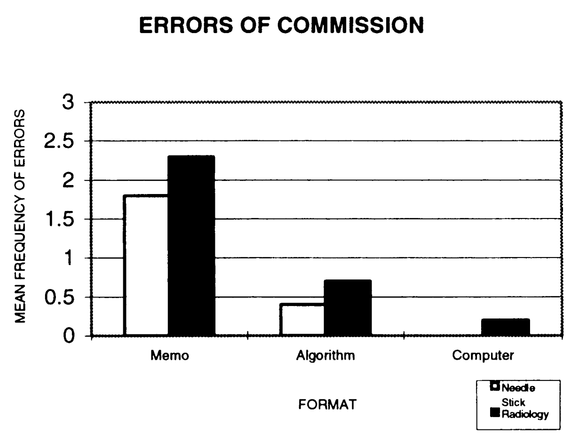

Figure 6. Mean frequency of errors of commission by format of presentation and the scenario policy used.

The goal of policy representation is to reduce the chances of spurious interpretation and error. We anticipated that the design of a computer-posed question/answer dialogue in the decision-assist program would allow no errors in interpretation of our experimental scenarios. In fact, in all three representations, subjects drew upon their own experience and opinions to pose questions and propose procedures outside of the specified policies. Thus, errors occurred in all representations. This suggests that personnel do not act as automatons. This independence of thought is likely part of an individuals ability to make good judgements in novel situations. This issue could be addressed by research into the cognitive psychology of decision making in health care environments.

During the follow-up and opinion portion of the study, most study participants stated they were ready to move from the written memo to a newer method of communication. Encouraged by the results of this study, we initiated a project to provide Emergency Medicine triage officers with computer-based decision support. This takes the form of triage guidelines presented by computer during the triage interview.[7]

Transforming written policy into its corresponding *All-Clear* script is not a trivial procedure. Our experience is that it takes between four and eight hours per policy to complete the transformation process. Conversion from the algorithmic flow chart to the decision-assist program consumes less than one hour. The personnel requirements for the conversion process include the ability to organize and write clearly. Computer skills needed are commensurate with those required by advanced word processing and spreadsheet programs.

An additional benefit of the on-line system is the ability to instantly update policy throughout an organization. Current methods of policy updates do not ensure concurrency between several work locations. By changing the database, all future look-ups will reflect the updated policy.

This system is not designed to replace all policy and procedure manuals. First of all, users of the system must have fast and easy access to computers as well as the skills to use them. Some policy and procedure applications require such portability (e.g. cleaning instructions on a housekeeping cart) that they are best left in paper form.

CONCLUSION

Policy that is easy to access, understand, and interpret will be used more readily by employees than that contained in multi-volume binders in a management office. In the hospital setting, clinical care providers need information in the fastest and most accurate form available. The computer decision support program in the proper operational envionment provides these qualities. Adequate access to computer workstations and a high quality, easy to use interface are prerequisites to successful implementation.

As clinical practice guidelines move into the mainstream of medicine,[3,8,9,10] methods that allow rapid and accurate assimilation of information and its transformation into action become paramount. Instituting the computer program throughout a health care facility would be ideal. However, it requires a computer network, appropriate hardware and staff willing to accept new technology.[11] In institutions unable to provide an adequate number of computer devices, policies could be converted into flow charts and added to the policy manual. Prior to the massive effort required by this paradigm shift of communication, further study in an operational environment is warranted.

ACKNOWLEDGEMENTS

We would like to thank Professor James Sayre, Ph.D. for assistance in the statistical analysis and Bruce Chernof, M.D. for his review and comments.

REFERENCES

1. Davis T, Crouch M, Wills G, Miller S, Abdehou D. The gap between patient reading comprehension and the readability of patient education materials. J Fam Prac. 1990; 31(5):141-3.
2. Gernsbacher M, Varner K, Faust M. Investigating differences in general comprehension skill. J Exp Psychol Learn Mem Cogn. 1990; 16(3):430-45.
3. Vaughn PB, Wolcott BW, Dupont S. Effective Algorithm-Based Triage and Self-Care Protocols: Quality Medicine at Lower Costs. Ann Emerg Med. 1980; 9(1):31.
4. Ebell M, Eaton T. Flow chart for the interpretation of do-not-resuscitate order statutes (editorial). J Fam Pract. 1992; 35(3):141-3.
5. Guidelines Committee of the American College of Critical Care Medicine. Guidelines for the transfer of critically ill patients. Crit Care Med. 1993; 21 (6):931-7.
6. Clear Software Inc. 385 Elliot Street, Newton, MA 02164
7. Guterman J, Mankovich N, Hiller J. Assessing the effectiveness of computer-based decision support system for Emergency Department triage. IEEE Engineering in Medicine and Biology. 15:594-595.
8. Stiell IG, McKnight RD, Greenberg GH, McDowell I, Nair RC, Wells GA, Johns C, Worthington JR. Implementation of the Ottawa Ankle Rules. JAMA. 1994; 271(11):827-32.
9. Quinlan JR. Decision trees and decisionmaking. IEEE transactions on Systems, Man, & Cybernetics. 1990; 20 (2)
10. Shiffman RN. Design and Implementation of a System for Computer-Assisted Telephone Triage in Pediatrics. SCAMC. IEEE Press. 1990; 826-30
11. Feeny S., Donovan A.; Changes in Attitudes Toward Computers During Implementation: Procedings of the 13th SCAMC. IEEE Press. 1989; pp 807-809